such lamentable teaching failures. Under these circumstances it would be ridiculous to "trust the teacher, trust him to teach, trust him to examine;" for, bad as examiners are, teachers are worse—partly for the same reason as that for which white sheep eat more than black, viz. that there are more of them.

And is it not also vain to attempt to replace the Examination system, even at the Universities, by a system of Thesis writing on some particular subject selected by the candidate, the Thesis being written by him at home, with ample opportunity for composing it out of works of reference, or with the assistance of his friends, with the addition of a small make-believe of "original research?"

We are told by one of the writers in the *Nineteenth Century* that, under our Examination system, England is losing her intellectual giants, men who are a head and shoulders above their contemporaries; but I ask is the writer aware that we have still among us Sir William Thomson, and that we have only recently lost Clerk Maxwell? People who speak thus seem to think that we are to expect a crop of intellectual giants to sprout up like a crop of mushrooms, and to be ready whenever we want them.

I would say in conclusion—let us retain Examinations, make them tests of a knowledge of the applications of principles, so that they will be real tests of intelligence, and not of cram; do not make them so difficult and so high-flown as they often are; and, finally, do not encourage the hurrying and skimming through a large number of different subjects, but make sure of the foundations by a more thorough and leisurely system of study.

THE LIFE-HISTORY OF A MARINE FOOD-FISH.[1]

I.

It is but a few years since the life-history of our most important marine food-fishes was involved in considerable obscurity—not only as regards popular views, but even in respect to the knowledge of men of science. Thus, for instance, in the years 1883 and 1884 the almost unanimous opinion of British fishermen was that our common food-fishes sought the shallow water of the bays and inshore ground generally for the purpose of depositing their eggs on the bottom. No observations specially bearing on this point had been made by British zoologists, and a series had to be undertaken for a public inquiry then in progress—with a result which demonstrated how extensive the reverse of the popular notion was. Again, certain comparatively recent authors on British fishes speak of a common fish like the gurnard as spawning twice a year, whereas, after careful observation, no evidence in support of this view has been obtained. The same obscurity veiled the larval and post-larval conditions of most of the food-fishes, even G. O. Sars—in regard to the latter stage—describing no intermediate forms between the larva of 6 mm. and the post-larval stage of 24 mm. in the cod, almost the only fish to which some attention had been paid.

On the other hand, our knowledge of the development and life-history of the fresh-water fishes—such as the salmon, trout, and charr—has for many years been well understood—thanks to the labours of Louis Agassiz and Vogt in Switzerland, Coste and Lereboullet in France, Ransom in England, and Shaw in Scotland, on the scientific side, and of the noblemen and gentlemen of Perthshire (ably seconded by Robert Buist) in connection with Stormont Field Ponds on the Tay, on the popular side. Much information has also been recently obtained by Dr. Day and Sir J. Gibson Maitland at the excellent ponds of the latter at Howietoun.

A short time ago, relying on experience derived from fresh-water fishes, not a few imagined the eggs of marine fishes as readily visible and tangible objects—possibly associated in their minds with certain practices in trout-fishing, or it may be with the manufacture of caviare. Recent investigations, however, have shown that in most marine food-fishes the eggs are minute glassy spheres which float freely in the ocean. For a knowledge of this fact we are indebted in the first instance to Prof. G. O. Sars, of Christiania, a naturalist trained from boyhood under a distinguished father, and who, by a fortunate appointment to a fishery post in Norway, was enabled to discover that the eggs of the cod, haddock, and gurnard, floated in the water, or, as we term it, were pelagic. He thus opened up a new field in the economy of the food-fishes, which in a great maritime country like ours ought not to have remained so long unexplored.

Lately, however, attention has been earnestly directed to the subject, and the labours of Cunningham, Brook, Prince, and others have made considerable advances in this department.

It is now known that the great majority of our British marine food-fishes—indeed, all our most valuable kinds (including even the sprat and the pilchard amongst the Clupeoids) produce minute eggs—as transparent as crystal, and which float freely throughout the water. These eggs, moreover, are not all shed at once, as in the case of the salmon, but successive portions of the ovary become ripe, and the eggs then issue externally. If by any accident or irregularity—as for instance the confinement of a flounder in an unhealthy tank—this gradational issue is interfered with, the animal dies from the great distention of the body caused by the pent-up eggs. In the case of the cod this gradual issue of the eggs continues probably for a week or two, so that the progeny of a single fish in one season may vary considerably in size.

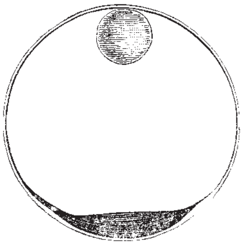

FIG. 1.[1]—Pelagic egg of the ling (enlarged).

From the early months of the year onward to late autumn the sea off our shores thus abounds with pelagic eggs, those of the rockling, haddock, and sprat being amongst the earlier forms, while the later include those of the sole. As indicated in the Trawling Report, and now supported by further experience, it would be a very difficult matter indeed to arrange for a close time in the sea—that is to say, for a limited period during which the mature fishes might be permitted to spawn in peace. This, however, in the case of individual species, such as the cod, might more readily be carried out, so as to save the mature fishes at the spawning period.

In a vessel of still sea-water these transparent glassy spheres rise at once on issuing from the fish, and form a stratum on the surface. Even the ripe portions of ovaries removed from the rejected viscera on a pier will show the same features, and thus, indeed, they first came before the lamented Lord Dalhousie at Anstruther. In the sea, however, they are seldom met with on the surface, and the tow-nets require to be sunk a fathom or two for their capture, their specific gravity being so little less than that of sea-water that they are carried hither and thither by the currents in every direction. Some indeed are captured near the bottom by nets attached to the trawl-beam, while experience with the large net of the St. Andrews Laboratory has proved that a great number are carried in mid-water.

---

[1] A Discourse delivered by Prof. W. C. McIntosh, F.R.S., at the Royal Institution, on Friday, February 1, 1889.

[1] I am indebted to Mr. E. E. Prince, B.A., for kindly aiding me with sketches for the woodcuts. The sketch of *Motella* is by Dr. Scharff.

When these glassy eggs issue from the female fish, they are soon fertilized in the surrounding water; so that in British waters, at any rate, non-fertilization is one of the rarest conditions in these pelagic eggs. It is indeed more likely to happen in the case of the herring, which deposits its eggs in masses on the bottom, or in artificial circumstances in tanks. The unfertilized egg soon becomes opaque and sinks, so that it is readily recognized.

In this connection I would again refer to the notion not long ago firmly rooted in the minds of many—especially those practically engaged in fishing—that the fishes at the spawning season seek the shallow water in which to deposit their eggs. Now there is little in Nature to support this idea. Shore-fishes, it is true, such as the lump-sucker and sea-scorpion (*Cottus scorpius*), do deposit their eggs there (and there cannot be a doubt that some of the masses of eggs thus deposited have been mistaken for those of the food-fishes); but the edible fishes proper, such as the cod, haddock, whiting, flounders, and others, appear to produce their eggs just where they happen to be feeding at the season. Their eggs are taken in charge by the ocean generally, and hence are independent of any imaginary protection or privilege pertaining to the shallow waters.

Moreover it does not follow that the fishes of an inclosed bay[1] will increase of themselves. As in the case of the plaice, in shallow sandy bays, it may happen that most of the large mature female fishes are beyond the limits, the half-grown or immature forms mainly occurring within; pelagic ova therefore must be borne inward, and still more the pelagic young, while the post-larval stages likewise migrate shorewards; a counter-migration of the older forms subsequently taking place to the deeper water. Such bays, therefore, have to depend for their stock of fishes on the unprotected off shore. If by any chance the latter waters were depopulated, the inshore would seriously suffer.[2]

The minute size of the eggs of all the important marine food-fishes enables a fish like the cod, for instance, to produce an enormous number—probably about 9,000,000, as against the 18,000 to 25,000 of the salmon or the 10,000 to 30,000 of the herring, both of which fishes deposit their eggs on the bottom. In the same way the very small eggs of the dab provide for a large annual increase of the species.

The translucent eggs, which, unless they contain a globule of oil, as in Fig. 1, are difficult to see in some instances even in a glass vessel, thus escape (by floating throughout the water) the vicissitudes to which a purely surface-life would expose them, such as the admixture of the surface-water with rain, and the attacks of gulls, ducks, and other forms; and they also are less at the mercy of the active predatory races living on the bottom, not to allude to the risks of being swept by storms on the beach or captured and destroyed by the ground-rope of the trawler. Nature, indeed, could have devised no method more secure than this for the safe propagation of those valuable fishes which for ages have peopled our waters, and I venture to say, with Prof. Huxley, will perhaps people them for ages yet to come, notwithstanding the persistent efforts of man to annihilate them.

Some good observers, for example Prof. Ryder in America, have attached much importance to the oil-globule in eggs which are pelagic, but its buoyant influence has been slightly over-estimated, for some contain no oil-globule, while the massive oil-globules in the eggs of the salmon and cat-fish have no such effect. They float, as well shown by my friend Mr. Edward E. Prince, Secretary to the Mussel and Bait Committee, solely in virtue of their specific gravity, which is somewhat less than that of sea-water. The moment fresh-water is added they sink, as they likewise often do when transferred from a vessel filled at sea into one containing shore-water.

While immediately after deposition these minute spheres are prone to accident from impurity and sudden changes in the temperature of the water, such would not seem to be the case after development has made some progress. Thus many living eggs will be found in odoriferous vessels brought from sea by the fishermen if the inclosed embryos have reached an advanced stage. Again, while carrying out some experiments on temperature (at the suggestion of Prof. Huxley) during the trawling expeditions, I had occasion to heat a test-tube containing some of the eggs of the flounder, so as to make them rush up and down the vessel most actively. Considerable heat was applied, and, under the impression that the eggs were irretrievably injured, the tube was set aside. Some days afterwards, when explaining the nature of the experiment to Prof. Ewart, he noticed motion in the tube, and further examination showed that after all this exposure to heat the little flounders had emerged as usual, and were alternately floating and swimming about in the water. On the other hand, severe frosts are fatal to ova crowded in shallow vessels, in many cases actual rupture taking place;[1] and the same occurs in large eggs, for example those of the cat-fish deposited on the bottom of the vessel.

Out of the little glassy sphere, after a longer or shorter interval (varying from a few days to a few weeks, according to temperature), comes a minute and nearly transparent fish which at first is often as passive in the currents as the eggs themselves.[2] It soon, however, uses its tail for swimming and its pectoral fins for balancing. Its shape is somewhat like that of a tadpole, partly from the large head, but mainly from the great size of the yolk-sac, which contains a store of nourishment on which the little mouthless creature, about 3 mm. long, sustains itself for a week or ten days. In this respect it somewhat resembles the young salmon, in which a much larger collection of the same food supports it for about six weeks amongst the gravel in the spawning-bed of the river, though a closer scrutiny reveals certain essential differences. Thus the store of nourishment in the yolk-sac of the salmon is taken up by the blood-vessels which branch in a complex manner over the whole yolk, whereas in the young cod, though the heart is present and pulsating, not a blood-vessel at first is seen, and none ever enters the yolk-sac. The absorption of this nourishment therefore must take place by aid of the cells and tissues themselves, and there is nothing specially wonderful in this, when the condition in the endoderm of *Hydra* and other instances of intracellular digestion are considered.

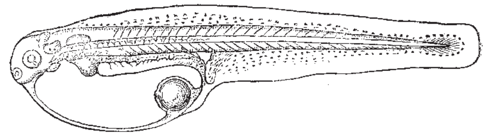

FIG. 2.—Larval ling immediately after hatching.

It has been mentioned that these minute and most delicate little fishes are nearly transparent, and this is more or less the case throughout, though in the majority—even before they leave the egg—points of pigment appear here and there in the skin, so as to give them a distinctive character. After hatching, these pigment-spots branch out in a stellate manner, thus becoming more evident, and it is found that in most cases each little food-fish has colours of its own. Thus the cod is known by its four somewhat regular black bands, the pigment on the haddock being less defined, the whiting by its canary-yellowish hue, the gurnard by its chrome-yellow, the ling by its gamboge-yellow, the flounder by its yellow and black, and so on. All these hues, however, become greatly modified during subsequent development; indeed, the pigment in no group of vertebrates shows more remarkable changes between the young and adult states than certain of our food-fishes. Thus for instance the cod is characteristically speckled in its tiny youth (Fig. 4), next it becomes more or less uniformly tinted, then the pigment groups itself somewhat irregularly on the sides (Fig. 5); thereafter it is boldly tessellated, subsequently blotched with reddish-brown, and finally in its adult condition it again puts on more or less uniform tints. The ling shows a similar series of transformations, the colours, however, differing in their arrangement, being marked with gamboge-yellow in its larval, slightly banded in its early post-larval stage, then the body becomes more or less uniformly tinted in its post-larval phase, and the little fish is furnished with a pair of enormously developed and bright yellow ventral fins (Fig. 7)—so different from the short ones of the adult. It is next striped conspicuously when about 3 inches long (Fig. 8), thus affording a great contrast to the tessellated condition of the young cod. In this stage an olive-brown band passes from the tip of the snout in a line with the middle of the eye, straight backward to the base of the caudal fin-rays. The pale ventral surface bounds it inferiorly, while a dorsal stripe with a beautiful opaline lustre runs from the tip of the snout, over the upper part of each eye to the tail, on which it is opaque white, thus giving the fish a characteristic appearance. The dorsal line from the brain backward is distinguished by a narrow edge of dull orange or pale olive, which relieves the colours formerly mentioned, and the general effect is varied by two black specks in the dorsals. When it is double the length (*i.e.* 6 or 7 inches), a complete change has taken place in its coloration (Fig. 9). Instead of being striped, the fish is now boldly and irregularly blotched—both dorsally and laterally, the region of the white stripe being indicated by the pale and somewhat scalloped area dividing the dorsal from the lateral blotches. Fourteen or fifteen brownish blotches occur between the pectorals and the base of the tail, and they are separated by the whitish areas, which thus assume a reticulated appearance, and both kinds of pigment invade the dorsal fins. Other touches of dark pigment on the fins and tail increase the complexity of the coloration at this stage.

---

[1] For example, closed by a Fishery Order.

[2] This feature was pointed out in the Report of H.M. Trawling Commission, under Lord Dalhousie.

[1] NATURE, June 1886.

[2] For some years the development of fishes has been studied by able workers: amongst others, on the Continent, by Götte, Kupffer, Hoffman, Henneguy, E. Van Beneden, Osjannikov, and Rafaele; in America, by Alex. Agassiz, Ryder, and Whitman; while in our own country, Ransom, Klein, Cunningham, Prince, and Brook have carried out similar researches.

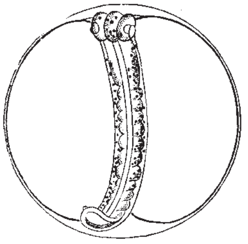

FIG. 3.—Flounder showing pigment *in ovo*.

FIG. 4.—Larval cod with black spots or bands.

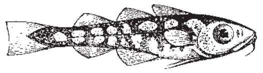

FIG. 5.—Aggregations of pigment in post-larval cod.

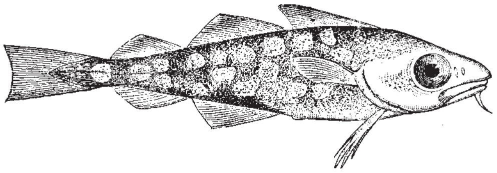

FIG. 6.—Tessellated condition of young cod (spirit-preparation).

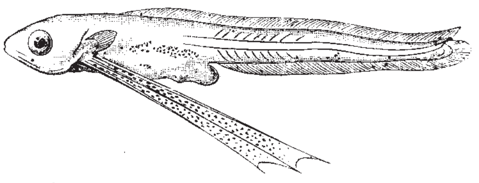

FIG. 7.—Long-finned post-larval ling (enlarged).

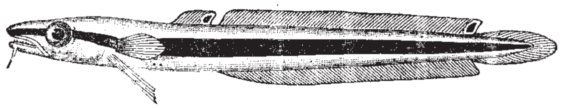

FIG. 8.—Young ling about 3 inches long (in spirit).

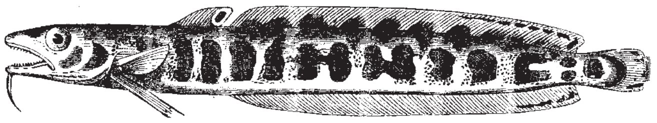

FIG. 9.—Young ling in the barred stage (about half natural size).

Again, some species, like the gurnard, have pigment over the yolk-sac before they are hatched, others have not. The dragonet in its post-larval (and pelagic) stage has its ventral surface deeply tinted with black pigment, while in the adult (a ground-loving fish) it is white. The St. Andrews cross in the eye of the post-larval four-horned Cottus (*C. quadricornis*) is another remarkable feature (Fig. 10). No more interesting or more novel field, indeed, than this exists in the whole range of zoology; but the investigations need ships and boats, with expensive appliances, as well as persevering work for several seasons. We have only been able to open the field at St. Andrews by the help of the Trawling Commission under Lord Dalhousie, and subsequently by the aid of the Fishery Board. It may be asked, Why is all this remarkable variation in colour? Just for the same reason that the young tapirs and wild pigs are striped, or the young red deer spotted—the adults in each case being uniformly tinted. Such features indicate their genetic relation with ancestral forms having these marks; and, moreover, in the struggle for existence, such variations in tint conduce to the safety of the young.

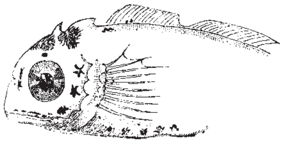

FIG. 10.—Head of *Cottus quadricornis*, with St. Andrews cross in eyes.

The view of Eimer that the markings in animals are primitively longitudinal would not suit for many fishes, notably for the young cod, ling, and Pleuronectids, and, indeed, Haacke has already pointed this out from a study of the Australian fish *Helotes scotus*,[1] the adult of which is marked by eight longitudinal bands, while young specimens present in addition a row of clear transverse bands which subsequently disappear.

(*To be continued.*)

NOTES.

On account of the severe illness of his child, Prof. Mendeleeff was obliged to leave London early on Tuesday morning, very greatly to the regret of those who assembled in the evening to hear him deliver the Faraday Lecture, which was read by the Secretary. It was announced that the dinner, at which the Fellows of the Chemical Society proposed to entertain Prof. Mendeleeff on Wednesday evening, would not take place, but that the President, Dr. Russell, and Miss Russell would receive at the Grosvenor Gallery on Friday evening, as before arranged.

The Ladies' *Conversazione* of the Royal Society will be held on Wednesday, June 19.

The *conversazione* of the Society of Arts will take place at the South Kensington Museum on Friday, June 28.

It has been decided that a statue shall be erected in honour of the late John Ericsson in Stockholm. His biography, papers, and letters will be edited by one of his most intimate friends, Colonel Church, of the American *Army and Navy Journal*.

Dr. George Owen Rees, F.R.S., died at Mayfield, Watford, Herts, on May 27. Dr. Rees took his degree of M.D. at Glasgow in 1837, and became a Fellow of the Royal Society in 1843.

It is requested that all persons having in their possession letters from the late President of Columbia College, Frederick A. P. Barnard, will be kind enough to send them to Prof. Nicholas Murray Butler, Columbia College, New York, U.S.A., at their early convenience. The letters will be returned after copies have been made.

Sir Lyon Playfair, who recently resigned the secretaryship of the Royal Commission of the Exhibition of 1851, has been succeeded by Major-General Ellis, Equerry to the Prince of Wales.

Allen's Indian Mail reports that Dr. Burgess, Director of the Archæological Survey of India, will come home immediately, and that he is retiring from his appointment.

The foundation-stone of the Framjee Dinshaw Petit Laboratory of Scientific Research, in Bombay, was laid on April 8 by Lord Reay. Mr. Petit, the son of the donor, explained that it had appeared to his father desirable, in the interests of medical education, that a laboratory for scientific research in biological and physical sciences should be established. He had long cherished the wish to have the properties of Indian drugs investigated, and made known to medical students. The laboratory, which will be connected with the Grant Medical College, was described by Lord Reay as the only missing link in the educational programme he had sketched out for Bombay.

The Allan Line steamer *Caspian*, which arrived from Halifax at Queenstown on Tuesday evening, reported having passed in the North Atlantic no fewer than thirteen large icebergs. The ship steamed quite close to one of them on Thursday last.

We are glad to be able to report the publication of synoptic weather maps twice a day by the Central Physical Observatory at St. Petersburg, beginning with May 12. The stations for which information is given extend from the west of Ireland to the Ural Mountains and the western shores of the Caspian, and from the north of Norway to the Trans-Caucasus, showing the weather-conditions at a glance, over nearly the whole of Europe. The atmospheric pressure is represented by isobars, and other elements by figures and symbols; the charts being printed on the back of the tabular reports, which have been issued since 1872. A general summary of the weather is given in Russian and French.

We print elsewhere a letter by Prof. Herdman on unusually large hailstones which fell at Liverpool on June 2. A correspondent writes to us from Rock Ferry about the same hailstones. "Five minutes after they fell," says our correspondent, "when the rain had subsided, I examined some. They were then all quite transparent outside, and had a spherical opaque centre surrounded by concentric rings alternately transparent and opaque. Some were flat: the largest I picked up measured one inch by three-quarters of an inch, and a quarter of an inch thick; its edge was very irregular. Others were more spherical in general form, but some still had rhombohedral faces very well defined. It was half an hour before all were melted."

On April 30, about 7 a.m., an earthquake was felt at Sokendal, in Dalerne, on the west coast of Norway. It was accompanied by a rumbling noise like distant thunder, going from east to west. The weather was clear and the wind north-west.

Serious efforts are being made to establish a great National Home-reading Circle Union, and we are glad to learn that they are likely to be successful. One object of the Union will be to publish courses of reading for three classes of readers—young persons, artisans, and general readers. The various courses will be approved by experts, and so planned as to interest and liberalize the mind as well as to convey useful information. Local circles will be formed under suitable leaders, and encouraged to meet frequently for the discussion of the subjects they have been studying. In many different ways the Union will try to aid the readers, and there can be little doubt that the scheme will be of real service to a very large number of persons who have often felt the need of guidance in their attempts at intellectual work. In all the courses science will receive the place which properly belongs to it, but adequate attention will also be given to literature and history.

Does the cuckoo ever hatch its own eggs? Herr Adolf Müller answers this question in the affirmative, and has given in the *Gartenlaube* a full account of a case which he himself claims to have observed. A translation of this account has appeared in the *Ibis*, and is reproduced in the new number of the *Zoologist*. The latter periodical prints also a translation of an article in which Herr Adolf Walter disputes the statements of Dr. Müller, who, he thinks, must have made a mistake. The same subject is dealt with in the June number of the *Selborne Magazine* by Mr. C. Roberts, who quotes from "Zoonomia" an interesting passage, in which Dr. Erasmus Darwin expresses his belief that the cuckoo sometimes makes a nest and hatches its own young. In this passage Dr. Darwin gives an extract from a letter of the Rev. Mr. Wilmot, of Morley, near Derby, describing an instance brought to Mr. Wilmot's notice in July 1792 by one of his labourers, and afterwards closely watched by Mr. Wilmot himself. Mr. Wilmot was confident that the bird was a cuckoo, but this is a point about which most ornithologists would no doubt like to have a little more evidence.

Everyone who takes the slightest interest in natural history will be sorry to learn that the kangaroo is in danger of being extinguished. Its skin is so valuable that large numbers of young kangaroos are killed, and high authorities are of opinion that, unless the process is stopped, Australians will soon have seen the last specimen of this interesting animal. Mr. R. G. Salomon, one of the largest tanners in the United States, whither kangaroo-skin is chiefly sent, urges that a fine should be imposed for the killing

---

[1] One of the Pristipomatidæ.